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CAUSES AND EFFECTS OF DENDROCTONUS VALENS ATTACKS ON RESERVE TREES IN AREAS TREATED BY SANITATION-SALVAGE METHODS IN PROVIDING TREES MORE SUSCEPTIBLE TO PRIMARY BARK BEETLE

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CAUSES AND EFFECTS OF DENDROCTONUS VALENS ATTACKS ON RESERVE TREES IN AREAS TREATED BY SANITATION-SALVAGE METHODS IN PROVIDING TREES MORE SUSCEPTIBLE TO PRIMARY BARK BEETLES

Studies of the relation of Dendroctonus valens Lec. activity to post-logging tree mortality on areas treated by sanitation-salvage methods have been in progress at the Black's Mountain Experimental Forest since 1939. These studies originated from observations on a few trees previously rated as low risk that died on treated areas following termination of logging activities. When examinations to determine the causes of tree mortality was made, the evidence indicated that death of the trees in some cases was the result of attacks by Dendroctonus valens followed by attacks of other aggressive insects. The occurrence of such tree mortality and the observations on the possible cause made it desirable to undertake a systematic study to determine the factors predisposing trees to attacks by D. valens on areas recently treated by sanitation-salvage methods. From the information gained in this way, it might be possible to formulate modifications in the sanitation-salvage marking practices that would reduce the probabilities of losses due to the activity of D. valens subsequent to cutting.

Work of the 1939-1940 Seasons

First observations of the few trees which had been attacked by D. valens in cutover areas showed these trees to be situated close to green stumps which had offered a breeding place for the beetles. It appeared that the attractiveness for the insect of these fresh stumps left by the logging activities had concentrated the beetles in the vicinity of the standing trees, resulting in their infestation and subsequent death. With these observations in mind, work of the 1939-1940 season was directed towards obtaining records on a series of stumps paired with green trees separated from the stumps by various distances. Additional pairs of standing trees on an uncut area served as controls. Results of the observations seemed to indicate that the distance of a stump from trees had no influence on the numbers of attacks on the stump, but was of importance in determining whether a tree was attacked, and perhaps also, the extent of the attack. No trees separated by more than seven feet from the stumps were attacked, and the tree with the most attacks was in contact with a stump. The value of these observations was limited, however, by the small number of attacked trees that were found during the season. (1)

The tendency of D. valens to attack low risk standing trees had been considered thus far to be the result of a specific reaction of the beetles when stumps were adjacent to the reserve of standing trees. In reviewing the report of the 1939-1940 study, Dr. Craighead (2) suggested that some experience in other regions has indicated that attacks on standing trees may result from a general increase in the beetle populations by their attraction to an area, or that changes in physical conditions within the stand consequent upon the cutting, such as changed light and shade relations on crowns, boles, or soil might predispose the remaining trees to D. valens attacks. For the purpose of obtaining additional data on the influence of these several factors on the post-logging activity of the insect, further work was planned for 1941. In addition to this program of study, a second phase was developed providing for the systematic observation of the biology of the species in the Black's Mountain area for the purpose of determining the periods of activity and sequence of broods and generations. A need for such information as an aid to synchronizing the main study with the behavior of the insect had become evident in the work of the previous years. The biological records would supplement also previous notes on the habits of the species in California pine forests. The results of these observations are being reported separately.

Study of Dendroctonus valens on Cutover Areas in 1941

Specific objectives:

The study of the behavior of D. valens on the areas treated by sanitation-salvage methods had two particular objectives in 1941. The first of these was the determination of the exact distribution of all Dendroctonus valens attacked trees on study plots in cut areas. Such information, it was believed, might indicate whether proximity to stumps or a general increase in the beetle population was more responsible under present conditions for the infestation of trees in the reserve stand. The second objective was the determination of the relation of changes in physical conditions for trees in the cutover area to the occurrence of D. valens attacks. The data accumulated for both objectives would offer the possibility for evaluating the several factors that might be contributing to the D. valens losses.

Organization of work:

Two compartments of the experimental forest where all high risk trees had been removed were chosen for study areas. The first of these was cut just before the first flight period of the beetles in June. The second was cut just prior to the second period of flight and attack in August. This choice of study areas made possible observations on the beetles during the periods of maximum activity. On each of the two compartments, P 15-33 and P 16-27, a five-acre plot 2½ chains wide and 20 chains long was laid out and the position of all

trees 12 inches or more in diameter at breast height and of all stumps was mapped accurately. All trees were numbered, their diameters, tree classes (Keen and Dunning), Risk class, and any special characteristics such as previous injuries noted. As a control for the two cutover plots, a ten-acre risk plot on a natural area of comparable forest type was used. On all three plots each tree was examined carefully for evidence of D. valens activity at two-week intervals until September 8, with a final checking over on October 8. Records were made of the numbers and success of new attacks occurring in each period. At the same time the occurrence of attacks on the green stumps of the cutover plots was followed also.

On the cutover plots the number of cases of stumps standing in contact with or in close proximity to reserve trees was limited. Therefore, to supplement the number of observations on such stump-tree groups, twelve stumps that were adjacent to one or more standing trees were examined on October 16. These trees and stumps, which were on Compartment P 15-33, had been situated together during the whole season of insect activity, and for this reason provided favorable material for observation.

Results of the Study:

The results obtained in the 1941 season are limited because of the small number of trees that were attacked. In spite of considerable activity of D. valens in stumps during midsummer, only two standing trees suffered attacks on the cutover plots. Examination of the twelve additional stumps and paired trees disclosed only three trees with new D. valens infestations. On the virgin control plot but three trees were attacked. The small number of infested trees that were found was unexpected since valens seemed quite numerous in 1941. Observations during the annual loss cruise of the forest area, in the course of the study of species relations in infested trees, and on stumps in cutover areas indicated that the species was relatively abundant as compared to previous years. Its numbers, however, were still small compared to the heavy infestations reported by Graham (3) and Hopkins (4, 5), and failed to result in the infestation of many standing trees on the cutting areas.

The first plot on cutover areas was established June 11. It contained 129 trees and fifteen stumps. During the course of the summer all of the stumps were heavily attacked, averaging 60 attacks per stump. Of the trees only two were attacked.

One tree was sixteen inches in diameter and low risk. Its position was 61 feet from the nearest stump. Its general physical environment appeared to be unaffected by the cutting program. Within two feet of the butt of the tree, however, lay a green top log about one foot in diameter from a tree removed in the course of the sanitation-salvage operations. While the log gave no evidence of attack by D. valens, at

ground level on the side of the standing tree facing the log three D. valens attacks occurred. The tree successfully pitched these out. It appeared that the insects were attracked to the log, and failing to attack this, attempted to enter the adjacent upright tree.

The second infested tree, was twenty-two inches in diameter and also of low risk. This tree was 97 feet from the nearest stump, and its general environment appeared to be unchanged by the logging. The base of the tree, however, had been struck a glancing blow by the top of a felled tree which lay within six inches of the tree stem. D. valens had attacked in five places about the logging scar and in the butt of the tree. These attacks were unsuccessful.

The second cutover plot was established August 4. It contained 21 stumps and 128 trees above 12 inches diameter at breast height. During the period of observation from August 4 to October 8, there was an average of 21 attacks per stump. None of the trees was attacked.

The ten-acre virgin control area embraced a stand of 230 trees. Observations were begun on the plot on June 9 and terminated on October 28. During this period three trees suffered D. valens attacks. All three trees were overmature and high risk. One tree experienced 10 attacks, of which 3 gave evidence of continued activity on the last date of observation. A second tree had 12 attacks, with 4 still appearing active at the onset of winter. The third tree had 8 attacks of which 5 were active at last inspection.

On October 16, 1941, 12 stumps paired with one or more trees were examined for evidence of attacks spreading from stumps to the trees. One low risk tree standing 17 feet from stump 58 showed one D. valens attack. This attack at the edge of a logging injury is believed to have been due primarily to the injury, and not to the presence of the stump some distance away. A second tree 1½ feet from a stump showed fourteen D. valens attacks all around the base of the stem up to 30 inches above ground. The attacks were variously successful, some of them containing larvae one-half grown. The tree which was low risk stood on the south side of the stump, so that cutting of the adjacent tree had probably little altered its light and shade relations. The stump also was heavily attacked by D. valens during the summer.

The third low risk infested tree was standing in contact with a stump. Four attacks took place on the standing tree, but these were pitched out. The stump was well-attacked by D. valens during the summer.

Discussion of Results:

From the above summary of cases of D. valens attacks in trees that were observed in 1941, it is evident that little data was obtained in addition to that which had been secured the previous year. It will be observed, however, that the only attacks on standing trees in cutover

areas were on trees either injured by logging or those close to stumps or green logs. This relation is in agreement with the observations of the previous years, and with other observations that lead to this study. It would appear that under conditions prevailing during the same interval in the experimental forest the D. valens attacks on leave trees have tended to occur under the influence of nearby stumps, green logs, or basal injuries which served as centers of attraction for the beetles.

The circumstances favoring D. valens attacks on green apparently healthy trees have been under observation by entomologists for many years. Under some conditions density of population in itself appears to have been the factor most responsible for aggressive D. valens behavior. A notable case exemplifying the action of this factor is recorded by Hopkins in his West Virginia report (4). It was observed that a large D. valens population developed during the course of a widespread Dendroctonus frontalis Zimm. epidemic. With the sudden subsidence of this epidemic the D. valens adults swarmed over the countryside and attacked healthy green trees over a wide forest area.

The occurrence of D. valens outbreaks in association with logging has been reported repeatedly by entomologists (3-4-5-7-8-11). In some cases attacks seem to have resulted from the increased density of populations of the beetles breeding up in the stumps of logging areas. Graham (3) made a study of D. valens on a logging site at Itasca Park. Prior to the study the beetles in this area were so abundant that they attacked green trees widely through the locality and gathered about dwellings. Considerable numbers of trees became infested. At the time the study was begun, however, the beetles were less numerous. It was observed that trees most heavily infested were standing near logs and slash. Under the conditions prevailing during the study Graham decided, "It seems probable that the infestation of trees standing near green logs is not due to beetle emerging from these logs, but to beetles attracted to the spot by the presence of freshly cut material. Once there they attack the trees." (p. 19) The greatest source of the beetle populations was the fresh pine stumps left by the logging. The beetles were highly successful in these. The conclusions of Graham with respect to the behavior of D. valens at a time when its numbers were declining seems to fit the circumstances of infestation at Black's Mountain where D. valens had been only moderately abundant.

The effect of changed physical conditions in inducing D. valens infestation may be a further factor under some conditions on the area. In cases where suppressed and shaded trees are left standing in full sunlight by the removal of dominant trees, such a change in the environment for the "leave" trees may have a deleterious reaction upon them leading to their infestation. Such trees probably would be standing near stumps, and the separation of both factors reacting upon the tree could not be made readily. A third factor may be operative under these circumstances. This would be a possible fusion of root systems of trees standing close together. Cutting of one tree and death of its root system might set in motion degenerative changes and the development of aggressive root fungi which would involve the root system of surrounding trees, making them more attractive to attacks of D. valens and other insects.

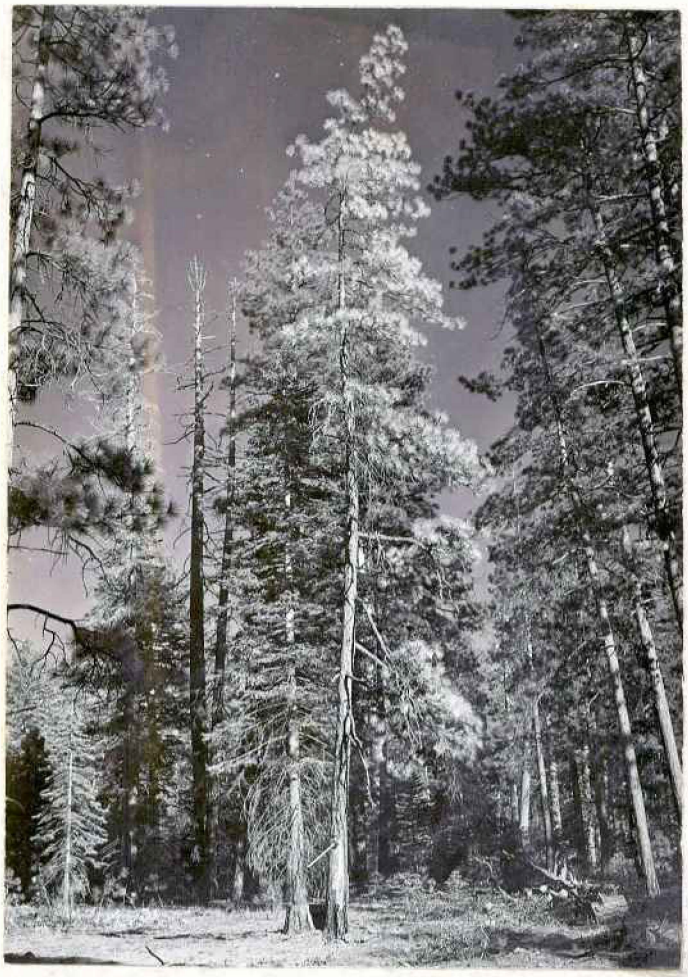

Plate 1. - A Dendroctonus valens Attacked Tree

This previously thrifty tree in the reserve stand of low risk trees on Compartment G 2-14, Black's Mountain Experimental Forest, was adjacent to the stump of a high risk tree removed in the sanitation-salvage treatment. Dendroctonus valens adults attracted to the stump infested the reserve tree also. Subsequent to the valens attacks Dendroctonus brevicomis filled in the upper bole, insuring the death of the tree. Negative 10173, by K. A. Salman.

A final factor of importance in the occurrence of D. valens losses in treated areas is the presence or absence of aggressive populations of other species of beetles. When they are present in numbers and are aggressive in their attacks, they tend to fill in the upper boles of trees which have been attacked and weakened by D. valens, thus bringing about the death of trees that might otherwise have recovered. Hopkins (4) early observed that D. valens attacking alone seldom caused the death of healthy trees even though its attacks were heavy. Other records by workers since then have confirmed this. Observations on some of the dead trees in cutover areas in 1938, 1939, and 1940 at Black's Mountain indicated that while D. valens was the first species to attack the trees, tree mortality probably had resulted from subsequent attacks by Dendroctonus brevicomis Lec. or Melanophila species. (Plate 1) In 1941 populations of these species were much reduced and unaggressive. In their absence trees attacked by D. valens may be able to overcome such injuries and survive.

The presence of high infestations of other pine destroying insects also would promote D. valens activity by providing additional host material for the development of large populations of the species. At Black's Mountain a period of increasing infestations of D. brevicomis provided breeding material for numbers of valens, which attacked the uninfested butt-ends of infested trees. With the decline in D. brevicomis and Melanophila activity in 1941 it may be expected that the numbers of D. valens from this source will diminish also.

Recommendations for control of losses from D. valens on cutting areas:

From a consideration of the various factors and conditions contributing to the occurrence of D. valens losses in areas treated by sanitation-salvage methods, it would appear that no single rule for control can be given that will apply in all cases. Control measures would be necessary only when certain conditions prevailed that were conducive to the occurrence of such loss. Three factors that would seem to be of most importance in favoring D. valens losses are (1) the presence of high populations of the species, (2) the presence of high and aggressive populations of other tree-killing insects, (3) the nearness of standing trees to stumps or green logs. When the first two conditions exist, effort should be made to control the third.

To reduce the possibilities of loss when conditions are favorable for it, control measures of two sorts may be taken, (1) those which render the stumps unattractive, or (2) those which isolate the stumps by removing trees adjacent to them at the time the high risk trees are cut. If it is desired to make the lightest possible cut, removing only high risk trees, the control measures of the first type should be applied. Dr. Craighead has suggested that piling brush on the stumps or barking them immediately after cutting have proved to be satisfactory methods for reducing the numbers of beetles attracted to green stumps. It is believed that such measures applied to stumps situated within a certain maximum distance of other trees would achieve adequate control of losses that might otherwise occur.

If it is desired, during cutting to remove a certain percentage of the stand in addition to the high risk trees, it could be recommended that all trees standing within a certain maximum distance of the high risk trees be cut also, thereby reducing potentialities of further loss after cutting, and meeting the demands of the cutting program at the same time.

Reference to the data thus far obtained im this study gives no indication of the maximum distance from stumps within which hazard of attack is greatest. Experience suggests that trees that are in contact with or within a few feet of stumps are most apt to be attacked. It is probable that a certain maximum distance could be chosen arbitrarily that would give satisfactory control.

Summary and Conclusion

During the past three field seasons a study has been in progress seeking the relationship of Dendroctonus valens Leconte activity to post-logging tree mortality on areas treated by sanitation-salvage methods at the Black's Mountain Experimental Forest. The study was undertaken as a result of observations that certain trees dying on areas given the cutting treatment had been attacked first by D. valens, and later by other insects. Attention was directed towards determining what factors were operative in inducing attacks of D. valens upon reserve trees in the treated stands. Three possible factors were considered: (1) the attractive influence of stumps and logging debris which concentrated attacking populations of beetles at certain points and resulted in the infestation of standing trees close by; (2) the increase in the general population of D. valens over the area of cutting by their attraction to and breeding in the green stumps, thus resulting in a greater chance for infestation in reserve trees; (3) alteration in the physical environment or root relations of the trees by cutting operations which make the trees more susceptible to D. valens attacks.

Since few cases of attacks on standing trees occurred during the period of the study, the records obtained remain insufficient for final conclusions regarding the relative importance of these several factors. Of the three considered, proximity of trees to stumps is believed to have been of definite importance in inducing attacks of D. valens on reserve trees. The presence or absence of other aggressive tree killing insects may be critical, also, in determining whether such attacked trees become wholly infested and succumb. Control of valens losses probably may be obtained by cutting of low risk trees standing within a few feet of trees marked for sanitation-salvage removal, or by piling brush over green stumps standing close to reserve trees. Need for control may be estimated by the apparent activity of Dendroctonus valens, Dendroctonus brevicomis, and Melanophila species.

Losses to date from D. valens attacks have been small. Insect activity at the present time also is low. In view of these circumstances it would not seem that further work would provide sufficient information to reach final conclusions on the objectives undertaken. Therefore, no further work is recommended.

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